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# Moulding containing a proportion of cork and process and apparatus for producing it

# Description

The invention relates to plastic mouldings containing a proportion of cork. Furthermore, the invention relates to a process and an apparatus for producing such mouldings.

Plastic mouldings serve as aids for assisting the human movement apparatus. Furthermore, they are also used as cushioning elements for the furniture and machine industries, as damping elements for machine construction and as padding elements in the clothing industry.

It is known that such plastic mouldings (insert blank) can be cast from a relatively hard polymer material.

It is also known that such insert blanks can be cut from a cork sheet, with this cork sheet having been previously manufactured from cork material in combination with synthetic resins.

After the appropriate insert shape has been cut out, this is introduced into a deep-drawing machine in which the blank is shaped to produce the desired orthopaedic shape.

The formation of a moulding for medical applications from a relatively hard polymer material suffers from the disadvantage that this material has a high hardness and the moulding manufactured therefrom, for example a shoe insole, is therefore unpleasant and uncomfortable in use.

In the second embodiment using a cork-synthetic resin sheet, there is the disadvantage that high manufacturing costs have to be accepted because a relatively high proportion of cork has to be present in

the plastic sheet and, furthermore, the required use of a deep-drawing tool is correspondingly expensive.

It is therefore an object of the present invention to configure a moulding of the type mentioned at the outset in such a way that it is simpler and cheaper to produce and satisfies demanding requirements in respect of damping and comfort when worn. In addition, the moulding should have a long life and be dimensionally stable in industrial use (dampers for machine construction).

This object is achieved according to the invention by a moulding containing a proportion of cork, which is characterized by a shaped product obtained by discharge of a reaction mixture of A and B, where A is a mixture of:

1. a hydrophilic polyurethane prepolymer,
2. granulated cork and/or cork flour and
3. reinforcing fibres

and

B a mixture of:

1. water and
2. a surface-active silicone.

The process of the invention for producing a moulding containing a proportion of cork is characterized in that

A a mixture of:

1. a hydrophilic polyurethane prepolymer,
2. granulated cork and/or cork flour and
3. reinforcing fibres

and

B a mixture of

1. water and
2. a surface-active silicone

are mixed with one another, the reaction mixture is introduced into a casting mould and the shaped article formed is removed from the mould after curing.

The invention further provides an apparatus for producing a moulding, which is characterized by a tank for accommodating the mixture A, which on application of pressure feeds the mixture via a valve into a metering device which is connected via a valve with a mixing chamber which is provided with a mixer and is also connected via a valve and a pump to a tank containing the component A, with the mixed material formed in the mixing chamber being delivered by discharge via its outlet end, for example by a centrifugation method, into a mould for shaping.

As a result of the inventive combination of the mixtures A and B, in particular as a result of the use of specific plastics in combination with granulated cork or cork flour together with reinforcing fibres, cork material and fibres are incorporated into the mixture which is foamed during the reaction so that a durable, pleasant-to-wear replacement part is obtained.

The mixture A is prepared from

1. a hydrophilic polyurethane prepolymer,
2. granulated cork and/or cork flour and
3. reinforcing fibres.

The hydrophilic polyurethane prepolymers are, in particular, polyisocyanate polyethers which react with the substances having groups containing active hydrogen, e.g. water, to form a foam. Such hydrophilic polyurethane prepolymers are known from US Patent

41 37 200 and are commercially available, for example under the trade name "Hypol". For the present purposes, particular preference is given to hydrophilic polyurethane prepolymers which are derived from toluene diisocyanate (TDI) and are commercially available under the trade name "Hypol FHP 2002". Suitable results are also given by hydrophilic polyurethane prepolymers which are based on methylenedi(phenyl isocyanate) (MDI) and are marketed under the name "Hypol 4000 and 5000", with the first-mentioned Hypol products generally giving softer foams. The polyurethane prepolymers are liquid at room temperature and easy to handle.

The cork constituent used in the mixture A comprises granulated cork and/or cork flour. The particle size of the cork constituent is generally in the range from 0.8 to 2 mm in diameter. Preference is given to a particle size range of from 1 to 1.5 mm in diameter. Very large particle sizes have the disadvantage that the particle is pushed upward in the polymer mixture in the direction of the mould surfaces during expansion or foaming of the polymer, which leads to an inhomogeneity. The particle size should therefore not be significantly above 2 mm.

Apart from the polymer component, the cork component also gives the moulding the necessary elasticity and natural coherence by use of the natural product cork.

The third constituent of the mixture A consists of reinforcing fibres. It is possible to use any type of natural and synthetic fibres for reinforcing the moulded product, for example fibres comprising cellulose, polyester, polyamide, polyacrylate, with polyester fibres being found to be particularly useful. Preference is given to using a polyester reinforcing fibre obtainable under the trade name "Grilene". The cut fibre lengths of fibre material used are preferably in the range from 2 to 8 mm, in particular from 4 to

6 mm. The fibre fineness can also be varied as desired. Advantageous fibre thicknesses are 1.7 dtex. Excessively long cut lengths of the fibres are to be avoided, since mixing of the materials then becomes difficult and the fibres get caught up on the mixing tools.

The second component, viz. the mixture B, comprises water and a surface-active silicone. The water is necessary for reaction with the polyurethane prepolymer to form foam, while the surfactant used produces a uniform cell structure, promotes good mixing of the components and has a favourable influence on the surface of the product. Organo silicone copolymers have been found to be particularly useful. Preferred surfactants of this type are commercially available under the name "Polyurax".

The mouldings of the invention are produced by preparing the components A and B separately, firstly by mixing of a hydrophilic polyurethane prepolymer, granulated cork and/or cork flour and reinforcing fibres and secondly by mixing water and a surface-active silicone, and mixing the two mixtures A and B with one another so that they react and introducing the reacting mixture into a casting mould where the mixture cures under the action of the exothermically generated heat to give the desired moulding.

The components A and B are advantageously mixed with one another in a ratio of 100 parts by weight of A:35-45 parts by weight of B.

A mixing ratio of A:B of 100:40 parts by weight is particularly preferred. However, the mixing ratios can be varied and the respective hardness of the orthopaedic replacement parts can be altered in this way.

It is advantageous to stir the granulated cork and reinforcing fibres into the polyurethane prepolymer at an elevated temperature up to about 50°C. At these temperatures, the polymer is relatively fluid so that the mixing process is aided. Mixing of the components of the mixture A is advantageously carried out by means of a mixer in order to achieve a homogeneous distribution, with the type of mixer being inconsequential. A homogeneous paste is obtained and this may, if appropriate, be allowed to rest for a while so that the cork granules are completely wetted by the polymer before the paste is reacted with the component B. A rest time of about half an hour is generally sufficient.

The component A is preferably prepared using 100 parts by weight of polyurethane prepolymer, in particular from 20 to 25, preferably 23, parts by weight of granulated cork and/or cork flour and from 0.5 to 2 parts by weight, in particular from 1 to 1.5 parts by weight, of reinforcing fibres.

The component B is prepared by mixing water with the surface-active silicone, advantageously using from 15 to 25 parts by weight, in particular 20 parts by weight, of silicone per 100 parts by weight of water.

The prepared mixtures A and B are then reacted by mixing, advantageously by means of a mixer, and the reaction mixture is immediately introduced into the mould, with the exothermically reacting reaction mixture expanding and the gases evolved being pushed out of the mould through small venting channels. The curing process occurs over from about 3 to 4 minutes, after which the moulding can be removed from the mould.

A superior process for producing cork-elastic mouldings which can be produced in a continuous process without complicated deep-drawing equipment merely by

discharging, by means of which tough, highly abrasion-resistant mouldings having pleasant properties when worn can be achieved is thus provided.

The present invention makes it possible to produce cork-elastic mouldings, for example shoe insoles, having a Shore hardness in the range from 20 to 60 Shore A and above.

According to a further development of the performance of the invention described here, it is also possible to create islands, for example on the moulding itself, which have a Shore range which differs from the abovementioned hardness values and, for example, are softer in the region of the ball when an orthopaedic application is intended.

For this purpose, a moulding which has recesses in, for example, the ball or instep region is firstly produced by the above-described process of the invention. In a further process step, these recesses are then filled with a softer cork/polymer/fibre mixture of the above-described type, taking care that homogeneous bonding to the previously produced moulding provided with recesses occurs at the edges.

These recesses can also be filled with pure foam, e.g. polyurethane prepolymer, i.e. without cork and fibre additions, to achieve particular effects as a result of the combination of such materials in various regions of the orthopaedic replacement part.

The invention is illustrated below with the aid of an example.

## Example

### Preparation of component A

From 1 to 1.5% by weight of polyester reinforcing fibres ("Grilene") having a cut fibre length of from 4 to 6 mm and a density of 1.38 g/cm$^3$ were introduced with stirring into 100 parts by weight of polyurethane prepolymer (Hypol-FHP-2002) which is heated to 40°C. 23% by weight of granulated cork having a particle size of from 1 to 1.5 mm in diameter is then mixed in in three equivalent amounts until a homogeneous paste is formed. The paste is then allowed to rest for about half an hour before further processing.

Preparation of component B

20 parts by weight of an organosilicone copolymer ("Polyurax SC-120") are added to 100 parts by weight of water.

The two components A and B are mixed with each other in a mixing ratio of 100 parts by weight of component A to 40 parts by weight of component B by means of a stirrer, whereupon the exothermic reaction commences immediately. The reaction mixture is introduced into an appropriately shaped mould to produce a plastic moulding. After curing in the casting mould for about 3-4 minutes, during which the gases evolved escape through small venting channels, the blank is removed from the mould.

The blank displays good elasticity and excellent strength and impact toughness, has pleasant properties when worn and is very abrasion-resistant. The surface microstructure is extraordinarily uniform and thus develops a high wearing comfort.

The apparatus of the invention which is described in detail below with the aid of the drawing is particularly useful for producing the mouldings of the invention.

Pressure can be applied to the mixture A present in a tank 4 by means of a pressure cylinder 1 having a push rod 2 and a pressure plate 3. At the outlet end 5 of the tank 4, there is a valve 6 for closing or opening the tank 4. The valve 6 opens into a metering chamber 7 of a piston metering device 8, with metering being carried out by means of a piston 9 whose piston rod 10 can be moved back and forth in the direction of the arrows 11. The metering chamber 7 is connected via a valve 12 to a mixing chamber 13 in which the mixing of the components A and B is carried out.

A tank 16 for accommodating the mixture B is likewise connected to the mixing chamber 13 and is connected via a pump 17, line 18 and valve 19 to the mixing chamber 13.

The mixing chamber 13 which is equipped firstly with the feed devices for the component A and secondly with the feed devices for the component B has a mixer 14 which is driven by a motor 15. The mixing chamber 13 opens into an outlet end 20 via which the reaction mixture is introduced into a mould (not shown).

The operation of the apparatus occurs in the following way:

The finished, premixed component A in the tank 4 is placed under pressure by means of the pressure cylinder 1 with push rod 2 and pressure plate 3. After the valve 2 is opened, the cylinder 1 is activated and the pressure plate moves downwards, as a result of which the material in tank 4 is introduced under pressure into the metering chamber 7. As a result, the piston 9 moves to the right, and is itself driven to the right until the metering chamber has attained the required volume. The valve 6 is then closed and the valve 12 is opened.

The piston is then driven to the left in the direction of the arrow 11 by means of its piston rod 10, as a result of which the material from the metering chamber 7 is introduced into the mixing chamber 13 in which the motor-driven mixer 14 rotates.

In parallel with the introduction of the material from the metering chamber 7 when the valve 12 is open, the introduction of the component B from the tank 16 occurs via the pump 17, line 18 and the open valve 19.

The valves 12 and 19 are thus open at the same time, so that intensive mixing of the two components A and B occurs in the mixing chamber 13. During the mixing process, the outlet end 20 of the mixing station 13 is open because mixing is carried out in a continuous process.

The components A and B are mixed in the mixing chamber 13 for about 3-4 seconds and react with one another. The reaction mixture is then introduced under pressure via the outlet end 20 into moulds (not shown).

The apparatus can be operated continuously.

If the apparatus is not operated continuously but batchwise, a cleaning cycle in the mixing chamber 13 has to be added. For this purpose, a valve, which is not shown in greater detail, is present, so that pure water can be introduced via this valve into the mixing chamber 13 and then be stirred about in the mixing station 13 on operation of the mixer 14. After cleaning is complete, the mixing chamber 13 is blown dry and is available for renewed filling with the components A and B.

The plant described above is merely an example. Further modifications are of course possible. For example, a hydraulically operated cylinder or another pressure

piston or another drive for the pressure plate 32 can be used instead of a pneumatically operated cylinder. It is also possible to use motor-driven spindles to apply the required pressure to the mixture in the tank 4.

Likewise, another metering device can be used instead of piston metering and another way of introducing the component B into the mixing chamber 13 can be employed instead of introduction via a pump and valve.

Legend for the drawing

| | |
|---|---|
| 1 | Pressure cylinder |
| 2 | Push rod |
| 3 | Pressure plate |
| 4 | Tank |
| 5 | Outlet end of the tank |
| 6 | Valve |
| 7 | Metering chamber |
| 8 | Piston metering device |
| 9 | Piston |
| 10 | Piston rod |
| 11 | Direction of arrow |
| 12 | Valve |
| 13 | Mixing chamber |
| 14 | Mixer |
| 15 | Motor |
| 16 | Tank |
| 17 | Pump |
| 18 | Line |
| 19 | Valve |
| 20 | Outlet end |

## Claims

1. Moulding containing a proportion of cork, characterized by a shaped product obtained by discharge

of a reaction mixture of A and B, where A is a mixture of:

1. a hydrophilic polyurethane prepolymer,
2. granulated cork and/or cork flour and
3. reinforcing fibres

and

B a mixture of:

1. water and
2. a surface-active silicone.

2. Moulding containing a proportion of cork according to Claim 1, characterized in that the cork is present in a particle size of from 0.8 to 2 mm in diameter, in particular from 1 to 1.5 mm in diameter.

3. Moulding containing a proportion of cork according to Claim 1 or Claim 2, characterized in that polyester fibres are present as reinforcing fibres.

4. Moulding containing a proportion of cork according to Claims 1-3, characterized in that the cut length of the reinforcing fibres is from 2 to 8 mm, in particular from 4 to 6 mm.

5. Process for producing a moulding containing a proportion of cork according to any of Claims 1-4, characterized in that

A a mixture of:

1. a hydrophilic polyurethane prepolymer,
2. granulated cork and/or cork flour and
3. reinforcing fibres

and

B a mixture of

1. water and
2. a surface-active silicone

are mixed with one another, the reaction mixture is introduced into a casting mould and the shaped article formed is removed from the mould after curing.

6. Process according to Claim 5, characterized in that the components A and B are used in a weight ratio of A:B of 100:35-45, in particular 100:40.

7. Process according to Claim 5 and Claim 6, characterized in that the component A used is a mixture of:

1. 100 parts by weight of a polyurethane prepolymer,
2. from 20 to 23 parts by weight of granulated cork and/or cork flour and
3. from 0.5 to 2 parts by weight of reinforcing fibres

and the component B used is a mixture of:

1. 100 parts by weight of water and
2. from 15 to 20 parts by weight of a surface-active silicone.

8. Apparatus for producing a moulding according to any of Claims 1-4, characterized by a tank (4) for accommodating the mixture A, which on application of pressure feeds the mixture via a valve (6) into a metering device (8) which is connected via a valve (12) with a mixing chamber (13) which is provided with a mixer (14) and is also connected via a valve (19) and a pump (17) to a tank (16) containing the component B, with the mixed material formed in the mixing chamber being discharged via its outlet end (20) into a mould for shaping.

1 page(s) of drawings attached

DRAWINGS PAGE 1

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